

Java™ magazine

By and for the Java community 

Working on the Leading Edge

17

GRAALVM:
COMPILING
TO NATIVE
BINARIES

26

JAKARTA EE:
THE NEW
ENTERPRISE
JAVA

37

CREATING RELIABLE
MICROSERVICES
EASILY WITH
NETFLIX HYSTRIX

54

JAVA ON ARM:
EASY PORTING
TO ARM-BASED
SERVERS



Would you rather be waiting... or coding?

41.1% of developers view **waiting for others** as a major bottleneck

35.1% say **subpar tools** hold them back

Meet
release
deadlines

**PICK
TWO**

Achieve
product
mandates

Stay
within
budget

Productivity bottlenecks lead to tradeoffs
in quality, performance & security

Download the ebook!

roguewave.com/java-bestpractices

Top 5 best practices for streamlining Java development



GraalVM: THE POLYGLOT VM AND JVM

By Oleg Šelajev

Easily combine languages in one project and benefit from ahead-of-time compilation.

OTHER FEATURES

66 The Visitor Design Pattern in Depth

By Ian Darwin

Perform one or more operations on different data types without disrupting existing code.

76 Fix This

By Simon Roberts and Mikalai Zaikin

More intermediate and advanced test questions

COVER FEATURES

26 JAKARTA EE: BUILDING MICROSERVICES WITH JAVA EE's SUCCESSOR

By Josh Juneau

A first look at using the emerging enterprise Java release for building microservices

37 BUILDING RESILIENCE INTO MICROSERVICES WITH HYSTRIX

By Henry Naftulin

This easy-to-use library from Netflix handles delays and failures in distributed applications.

54 JAVA ON ARM PROCESSORS

By Aleksei Voitylov

Arm already is a leading architecture for IoT and embedded processors. Recent 64-bit releases are pushing Arm CPUs onto servers, where they have full JDK support.

DEPARTMENTS

05 From the Editor Using comments to design classes

08 Java Books Review of *A Philosophy of Software Design*

10 Events Upcoming Java conferences and events

14 User Groups Istanbul JUG

91 Contact Us Have a comment? Suggestion? Want to submit an article proposal? Here's how.

EDITORIAL

Editor in Chief

Andrew Binstock

Senior Managing Editor

Leslie Steere

Copy Editors

Lea Anne Bantsari, Karen Perkins

Contributing Editors

Simon Roberts, Mikalai Zaikin

Technical Reviewer

Stephen Chin

DESIGN

Senior Creative Director

Francisco G Delgadillo

Design Director

Richard Merchán

Senior Designer

Arianna Pucherelli

Designer

Jaime Ferrand

Senior Publication Designer

Sheila Brennan

Production Designer

Kathy Cygnarowicz

PUBLISHING

Group Publisher

Karin Kinnear

Audience Development Manager

Jennifer Kurtz

ADVERTISING SALES

Tom Cometa

Mailing-List Rentals

Contact your sales representative.

RESOURCES

Oracle Products

+1.800.367.8674 (US/Canada)

Oracle Services

+1.888.283.0591 (US)

ARTICLE SUBMISSION

If you are interested in submitting an article, please [email the editors](#).

SUBSCRIPTION INFORMATION

Subscriptions are complimentary for qualified individuals who complete the [subscription form](#).

MAGAZINE CUSTOMER SERVICE

java@omeda.com

PRIVACY

Oracle Publishing allows sharing of its mailing list with selected third parties. If you prefer that your mailing address or email address not be included in this program, contact [Customer Service](#).

Copyright © 2018, Oracle and/or its affiliates. All Rights Reserved. No part of this publication may be reprinted or otherwise reproduced without permission from the editors. *JAVA MAGAZINE* IS PROVIDED ON AN "AS IS" BASIS. ORACLE EXPRESSLY DISCLAIMS ALL WARRANTIES, WHETHER EXPRESS OR IMPLIED. IN NO EVENT SHALL ORACLE BE LIABLE FOR ANY DAMAGES OF ANY KIND ARISING FROM YOUR USE OF OR RELIANCE ON ANY INFORMATION PROVIDED HEREIN. Opinions expressed by authors, editors, and interviewees—even if they are Oracle employees—do not necessarily reflect the views of Oracle. The information is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle. Oracle and Java are registered trademarks of Oracle Corporation and/or its affiliates. Other names may be trademarks of their respective owners.

Java Magazine is published bimonthly and made available at no cost to qualified subscribers by Oracle, 500 Oracle Parkway, MS OPL-3A, Redwood City, CA 94065-1600.

Cut Your Amazon Bill in Half



Easy to Move—Guaranteed Savings

There's the cloud... and there's the
Oracle Autonomous Cloud.

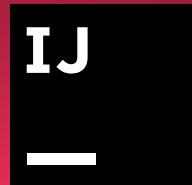
#thinkautonomous

ORACLE®

oracle.com/thinkautonomous

Guarantee applies to same data warehouse or transaction processing workload run on Oracle Autonomous Database Cloud and AWS. Pricing based on standard published pricing for Oracle bring your own license and AWS as of 3/1/18. Workload comparison to be based on actual required number of OCPU/VCPUs, storage amount, and time required to complete workload with minimum workload of one hour. Any credits due will be applied to Universal Credit cloud account. Offer valid through 5/31/19. Copyright © 2018, Oracle and/or its affiliates. All rights reserved. Oracle and Java are registered trademarks of Oracle and/or its affiliates. Other names may be trademarks of their respective owners.



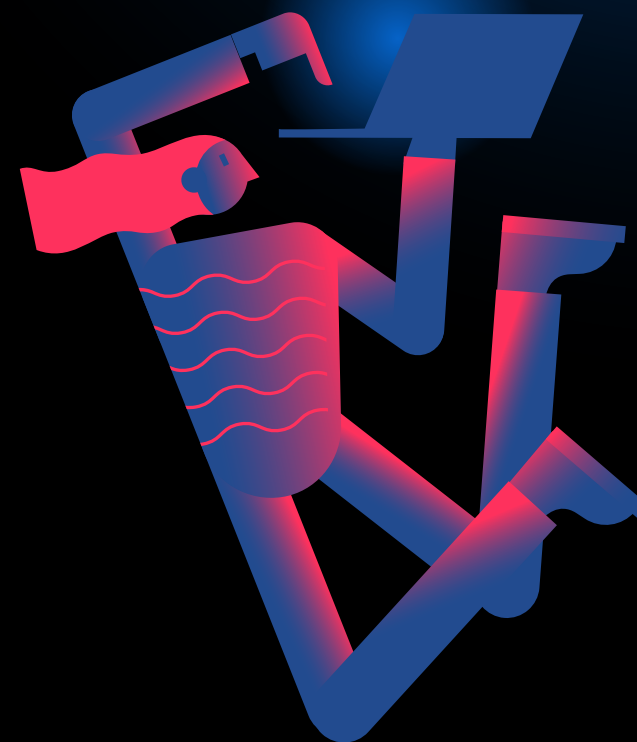


IntelliJ IDEA

Capable and Ergonomic IDE for JVM

Indepth coding assistance
Cross-language refactorings
Clever error analysis
and much more.

Download at jetbrains.com/idea



THE DRIVE
TO DEVELOP



06



Oct. 22–25, 2018 | San Francisco | #CodeOne

ORACLE CODE ONE

Code the Future, Together

- Discover the Latest on Java—from the Source
- Be a Part of Technologies that are Changing Everything
- Connect with Your Global Community

REGISTER NOW

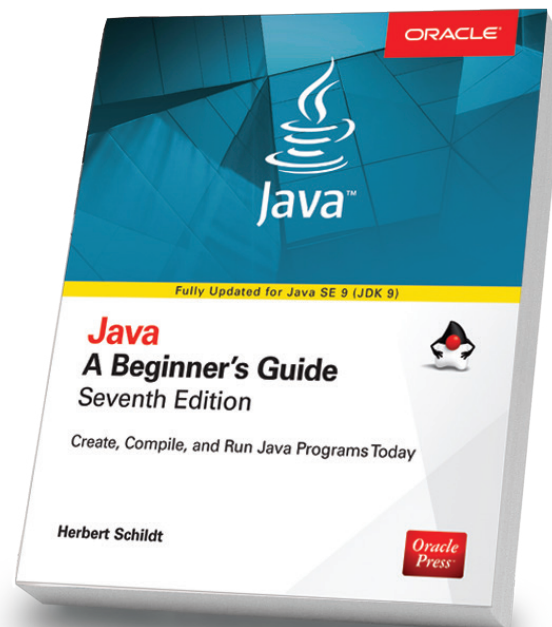
ORACLE®

// Silver Sponsor



*Discount based on the onsite registration price. Copyright © 2018, Oracle and/or its affiliates. All rights reserved. Oracle and Java are registered trademarks of Oracle and/or its affiliates.

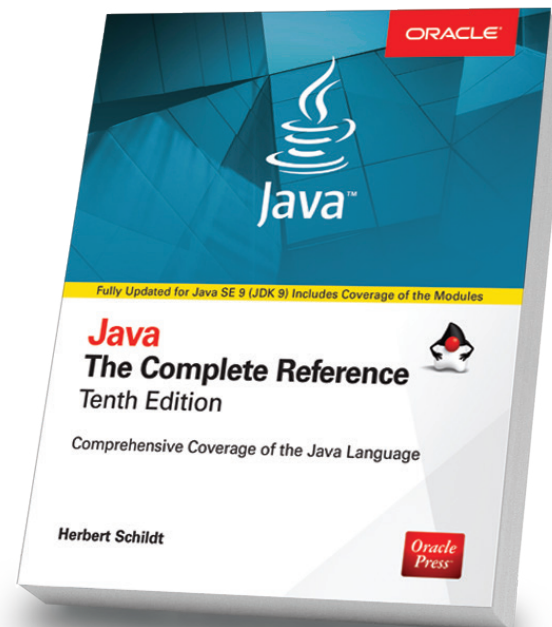
Written by leading experts in Java, Oracle Press books offer the most definitive, complete, and up-to-date coverage of Java available.



Java: A Beginner's Guide, 7th Edition

Herb Schildt

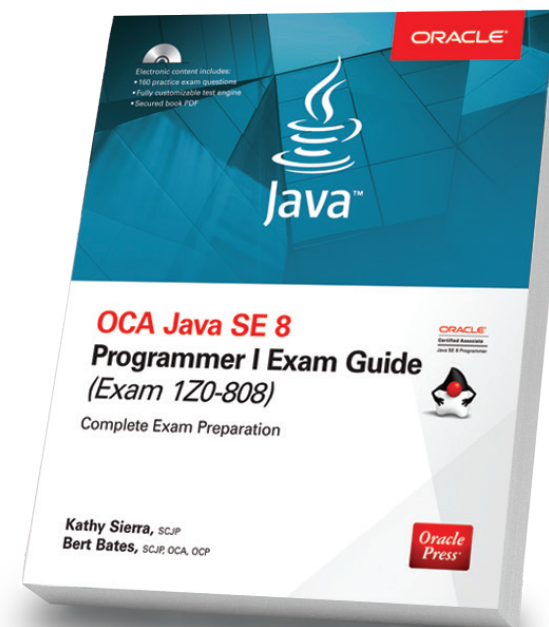
Revised to cover Java SE 9, this book gets you started programming in Java right away. Free online supplement covering key new features in JDK 10 available for download on the book's page on OraclePressBooks.com



Java: The Complete Reference, 10th Edition

Herb Schildt

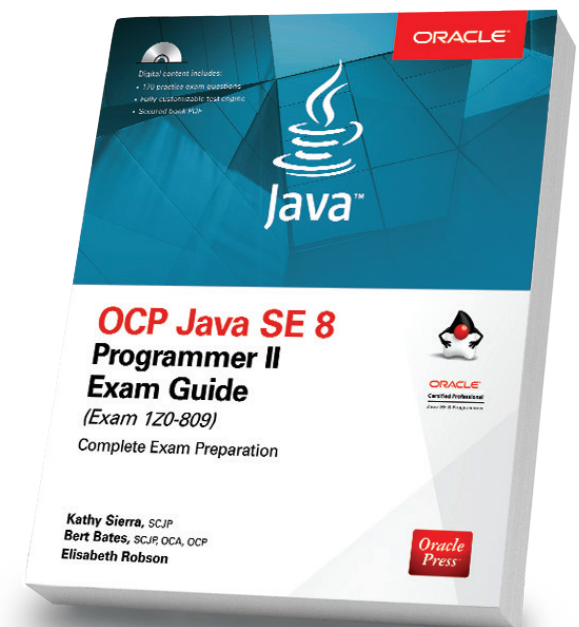
Updated for Java SE 9, this book shows how to develop, compile, debug, and run Java programs. Visit the book's page on OraclePressBooks.com to download free supplements on JDK's key new features.



OCA Java SE 8 Programmer I Exam Guide (Exam 1Z0-808)

Kathy Sierra, Bert Bates

Get complete coverage of all objectives for Exam 1Z0-808. Electronic practice exams include more than 200 questions that help you prepare for this challenging test.



OCP Java SE 8 Programmer II Exam Guide (Exam 1Z0-809)

Kathy Sierra, Bert Bates, Elisabeth Robson

Prepare for the OCP Exam 1Z0-809 with this comprehensive guide which offers every subject appearing on the exam. Includes more than 350 practice questions.

//events/



Oracle Code One

OCTOBER 22–25

SAN FRANCISCO, CALIFORNIA

The annual JavaOne event has been remade as Oracle Code One, a new developer conference that includes more languages, technologies, and developer communities. Look for talks on Go, Rust, Python, JavaScript, and R, along with the great Java technical content that developers expect. Topics will include microservices, containers, AI, chatbots, blockchain, and databases. A Java keynote and community keynote will remain, and all of the Java-focused community activities are being carried forward including IGNITE sessions, Community Day (now as a track), Java Champion briefings, and Duke's Choice Awards. (Note that registration is to Oracle OpenWorld, which is collocated with Oracle Code One.)

JSCamp

SEPTEMBER 22

CHICAGO, ILLINOIS

JSCamp is a one-day single-track conference for developers interested in JavaScript. Speakers will cover topics such as Node, React, Vue, and Ember for both beginners and experts.

jDays

SEPTEMBER 25

GOTHENBURG, SWEDEN

jDays brings together software engineers from around the world to share their experiences in different areas such as Java, software engineering, IoT, digital trends, testing, agile methodologies, and security.

Strange Loop

SEPTEMBER 26–28

ST. LOUIS, MISSOURI

Strange Loop is a multidisciplinary conference that brings together the developers and thinkers building tomorrow's technology in fields such as emerging languages, alternative databases, concurrency, distributed systems, and security. Talks are generally code-heavy and not process-oriented.

Functions

SEPTEMBER 28

TORONTO, CANADA

Functions is a community-focused, single-track conference exploring serverless development and architecture. Past conference speakers have included JS Foundation's Darcy Clarke and Google's Sandeep Dinesh.

NFJS New England Software Symposium

SEPTEMBER 28–30

FRAMINGHAM, MASSACHUSETTS

This developer event covers the latest trends within the Java and JVM ecosystem. Scheduled are talks on Java 9, reactive APIs, and microservices. Team attendance is encouraged.

Emerging Technology Conference

OCTOBER 2–3

SAINT PAUL, MINNESOTA

This conference explores the emerging technologies that are shaping the world, including machine learning, blockchain, and virtual/augmented reality.

**DevOpsDays Detroit**

OCTOBER 3–4

DETROIT, MICHIGAN

DevOpsDays is a worldwide community conference series for anyone interested in information-technology improvement. This year marks its fourth annual iteration in Motor City.

KotlinConf

OCTOBER 3, WORKSHOPS

OCTOBER 4–5, CONFERENCE

AMSTERDAM, THE NETHERLANDS

This is the principal conference for the popular JVM language, Kotlin. Keynotes by Kotlin Project Lead Andrey Breslav and Purple Evolution CEO Alicia Carr are slated.

Desert Code Camp

OCTOBER 6

CHANDLER, ARIZONA

Desert Code Camp is a free, developer-based conference built on community content. This year's sessions include talks on serverless microservices and building a website with Angular.

JAX London

OCTOBER 8 AND 11, WORKSHOPS

OCTOBER 9–10, CONFERENCE

LONDON, ENGLAND

JAX London is a four-day conference for software engineers and enterprise-level professionals, bringing together the world's leading innovators in the fields of Java, microservices, continuous delivery, and DevOps. Topics

slated for this year include delivering new features in the JDK, developing Java applications on blockchain with web3j, and cloud-native Java with OpenJ9.

JCON

OCTOBER 9–11, CONFERENCE

OCTOBER 12, TRAINING

DÜSSELDORF, GERMANY

JCON is for professional Java developers interested in core Java, enterprise Java, frameworks, and microservices. Daily focus starts with cloud and DevOps, moves to big data, and finishes with architecture and agile. A parallel XDEVCON conference focuses on rapid cross-platform development.

re:develop

OCTOBER 12

BOURNEMOUTH, ENGLAND

This platform-agnostic developer conference returns after a one-year hiatus and will address key new methodologies and practical advice for approaching development projects more effectively.

JFuture

OCTOBER 13

MINSK, BELARUS

This event gathers Java developers, software engineers, and technology enthusiasts and will focus on major updates of Java and popular Java frameworks. Modularity, Spring, Kotlin, and Rust are slated topics.

Java Enterprise Summit

OCTOBER 17–19

DÜSSELDORF, GERMANY

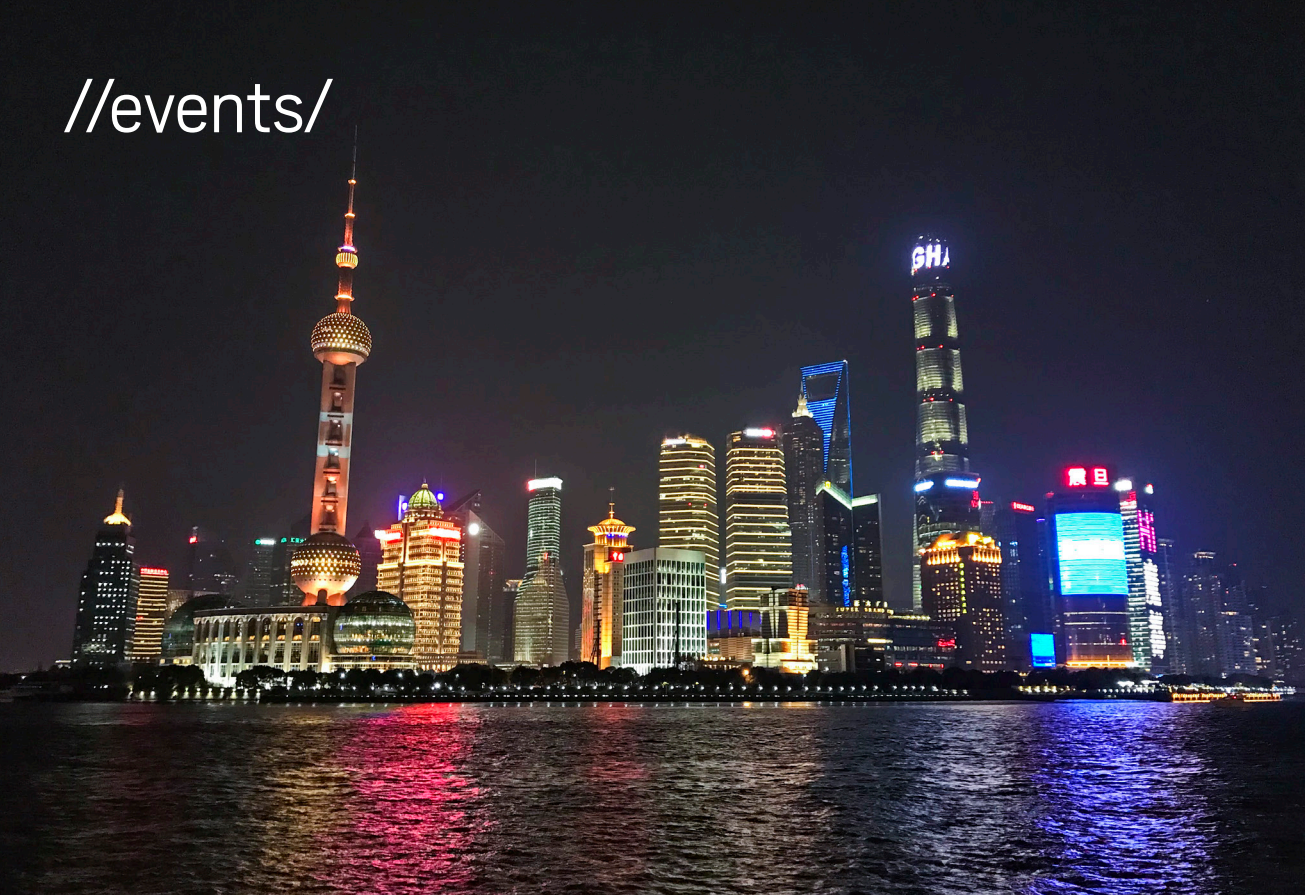
The Java Enterprise Summit is a Java EE training event exploring new paradigms such as microservices, API design, and state-of-the-art enterprise Java applications. (Website in German.)

All Things Open

OCTOBER 21–23

RALEIGH, NORTH CAROLINA

This annual conference explores open source, open tech, and the open web in the enterprise. Speakers this year include Netflix senior performance architect Brendan Gregg and AWS principal technologist Alolita Sharma. The theme this year is open source software and future disruption.

**KubeCon + CloudNativeCon**

NOVEMBER 13–15

SHANGHAI, CHINA

This conference gathers leading technologists from open source cloud-native communities to further the advancement of cloud-native computing. Simultaneous Mandarin-English translation will be provided for all keynotes and sessions.

Codemotion Berlin

NOVEMBER 20–21

BERLIN, GERMANY

Codemotion conferences are devoted to developers sharing the latest tech information and best practices among the tech community worldwide. Confirmed speak-

ers at this event include Picnic CTO Daniel Gebler and Apache Software Foundation member Kanchana Welagedara. The event is open to all languages and technologies and features coding lectures and workshops.

Topconf Tallinn

NOVEMBER 20–22

TALLINN, ESTONIA

Topconf Tallinn is an international software conference covering Java, open source, agile development, architecture, and new languages.

JVM-Con

NOVEMBER 27–28

COLOGNE, GERMANY

Among the topics slated for this conference devoted to JVM lan-

guages are the JRE, Java 9, Java EE 8, and cloud-native development. (Website in German.)

Codemotion Milan

NOVEMBER 29–30

MILAN, ITALY

Codemotion conferences are devoted to developers sharing the latest tech information and best practices among the tech community worldwide. Confirmed speakers at this event include Rogue Wave Senior Software Engineer Enrico Zimuel, ThoughtWorks Quality Analyst Wamika Singh, and Accenture Manager Maurizio Mangione. The event is open to all languages and technologies and features coding lectures and workshops.

DevTernity

NOVEMBER 30–DECEMBER 1

RIGA, LATVIA

The DevTernity forum covers the latest developments in coding, architecture, operations, security, leadership, and many other IT topics. Venkat Subramaniam, author of *Programming Concurrency on the JVM* and *Functional Programming in Java*, is slated to be one of the featured speakers.

ArchConf

DECEMBER 10–13

CLEARWATER, FLORIDA

ArchConf is an educational event for software architects, technical leaders, and senior developers presented by the No Fluff Just Stuff software symposium. Among the slated sessions are talks on applying design patterns, building serverless applications, machine learning, and scalable microservices.

CodeMash 2019

JANUARY 8–11, 2019

SANDUSKY, OHIO

CodeMash is an event that educates developers on current practices, methodologies, and technology trends in a variety of platforms and development languages such as Java, .NET, Ruby, Python, and PHP. The Java track features participation from many Java Champions.

Are you hosting an upcoming Java conference that you would like to see included in this calendar? Please send us a link and a description of your event at least 90 days in advance at javamag_us@oracle.com. Other ways to reach us appear on the last page of this issue.

**DEVELOPER COMMUNITY EVENTS FROM THE DEVOXX FAMILY
COMING SOON**

DEVOXX™

DEVOXX.COM

BELGIUM 12-16 NOVEMBER

UKRAINE 23 - 24 NOVEMBER

MOROCCO 27 - 29 NOVEMBER

TICINO 20 OCT

BRISTOL 25 OCT

BANFF 26 - 27 OCT

MICROSERVICES, PARIS 29 – 31 OCT

THESSALONIKI 19 - 20 NOV

CLUJ-NAPOCA 22 NOV



VOXXEDDAYS

VOXXEDDAYS.COM

Few programming languages make it past 20 years and still retain high popularity. But Java has managed to remain widely used in many contexts because of its evolution—not just of the language, but of the larger direction of the ecosystem. None of this is clearer than in the advent of GraalVM, an ahead-of-time native compiler for Java code that coincidentally is written in Java and supports many other languages—both JVM-based and native. To understand how to use Graal for your own projects, see our article on [page 17](#).

Much of Java’s success comes from new tools contributed as open source. Hystrix from Netflix is an excellent library for assuring uptime in distributed apps—especially microservices. Our coverage of Hystrix ([page 37](#)) shows its benefits and elegance of implementation.

We also include the next installment ([page 66](#)) of our series on design patterns, this time covering the Visitor pattern. And of course, this issue includes our usual quiz ([page 76](#)), editorial ([page 5](#)), and a book review ([page 8](#)) of an unusually interesting volume. Enjoy!




```
Context context = Context.create();
Value result = context.eval("js", "42");
assert result.asInt() == 42;
```

`Value` is how languages communicate with each other. Any Java object can be converted to a `Value` with the `Value.asValue(Object value)` method call, and the `Value` can be converted to its Java counterpart with `Value.as(Class<T> targetType)`. The exact description of the conversion process is outside the scope of this article, but the [API](#) always tries to do the sensible thing: it converts numbers to numbers, strings to Strings, values that can be executed to functional interfaces, collections to collections, and so on. For example, all of the following expressions are true:

```
context.eval("js", "'foobar'").as(String.class).equals("foobar");
context.eval("js", "{foo:'bar'}").as(Map.class).get("foo").equals("bar");
@FunctionalInterface interface IntFunction { int f(int value); }
context.eval("js", "(function(a){a})").as(IntFunction.class).f(42) == 42;
```

Armed with the **Context** and the **Value**, you can pass data between the components written in different languages.

However, a modern application will probably hide the details of the polyglot implementation of its components behind some abstraction. For example, this [demo application](#) is a Spring Boot web app that uses R to plot CPU utilization data as an SVG image.

In the app, the GraalVM polyglot context is defined as a Spring `@Bean`:

```
@Bean
public Context getGraalVMContext() {
    return Context.newBuilder().allowAllAccess(true).build();
}
```



■ Listing 7: Configuring the monitoring application

```
@SpringBootApplication
@EnableHystrixDashboard
public class HystrixMonitorApplication {

    public static void main(String[] args) {
        SpringApplication.run(HystrixMonitorApplication.class, args);
    }
}
```

Here, the annotation that enables the Hystrix dashboard does the trick. Run the services and paste the stream URL (<http://localhost:8088/hystrix.stream>) into the Hystrix dashboard application (at <http://localhost:8078/hystrix/>), as shown in **Figure 1**.

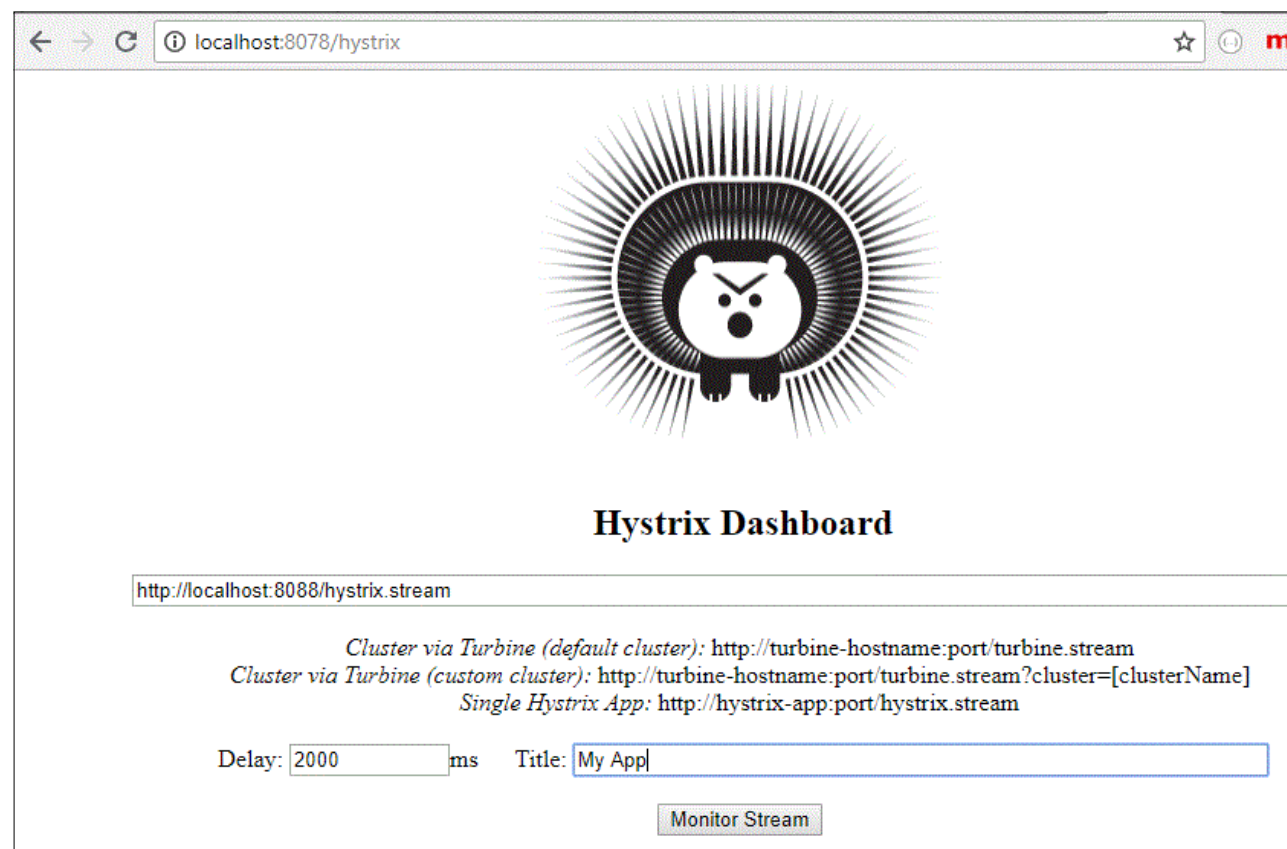


Figure 1: Hystrix dashboard application



developer.oracle.com/java
DEVELOP WITH THE
GLOBAL STANDARD

#1 Developer Choice for the Cloud

12 Million Developers Run Java

21 Billion Cloud-Connected Java Virtual Machines

38 Billion Java Virtual Machines are in the Cloud

Ian Darwin (@Ian_Darwin) has done all kinds of development, from mainframe applications and desktop publishing applications for UNIX and Windows, to a desktop database application in Java, to healthcare apps in Java for Android. He's the author of *Java Cookbook* and *Android Cookbook* (both from O'Reilly). He has also written a few courses and taught many at Learning Tree International.

Previous design patterns
presented in this series:

State Pattern

Command Pattern

In Java, all arguments to method calls are pass by value. That is, the value of the argument variable is copied into a new variable for use by the method. However, the value of a variable of object type is itself a *reference*, so the method has access to the original object through that reference.

Question 3
page 78

Answer 3. The correct answer is option E. The exam objectives include determining whether exam takers have knowledge of several elements of the Collections API, including the `TreeSet`. Two things are significant in the word `TreeSet`. A Set rejects duplicate entries, but in this question no duplicates are offered. The second thing is that a tree structure facilitates fast data searches by putting the data items in locations based on their order. For this to happen, there must be an order associated with the items being stored.

In a Java `TreeSet`, this ordering is determined when the collection is initially built, and it can be supplied in either of two ways:

- Using the natural order of the items. A “natural order” is defined in the Java API documentation as being the order implicit in the object’s implementation of the `java.lang.Comparable` interface. The `Item` class in this question does not implement that interface.
- Using an externally provided ordering. Such an order is provided via an implementation of the `java.lang.Comparator` interface. As already mentioned, the order is determined at the time the collection is constructed; therefore, the comparator must be supplied as a constructor argument. In this example, no such argument is provided.

Because neither of the options for specifying order is used in this question, the tree cannot work properly. So, how might this failure be visible?

There are three possibilities: the code doesn't compile, the code fails to store items in a rapidly retrievable way (perhaps storing them randomly and then failing to find them), or an exception is thrown. In fact, after a `TreeSet` has been created without a `Comparator` to use for ordering, any attempt to add an object that does not implement the `Comparable` interface will cause the `TreeSet.add` method to throw a runtime exception. Because of this, option E is correct.

Let's examine the background for some of the other options.

Clearly, if `TreeSet` is expected to put items into order, then option A is tempting, because it

